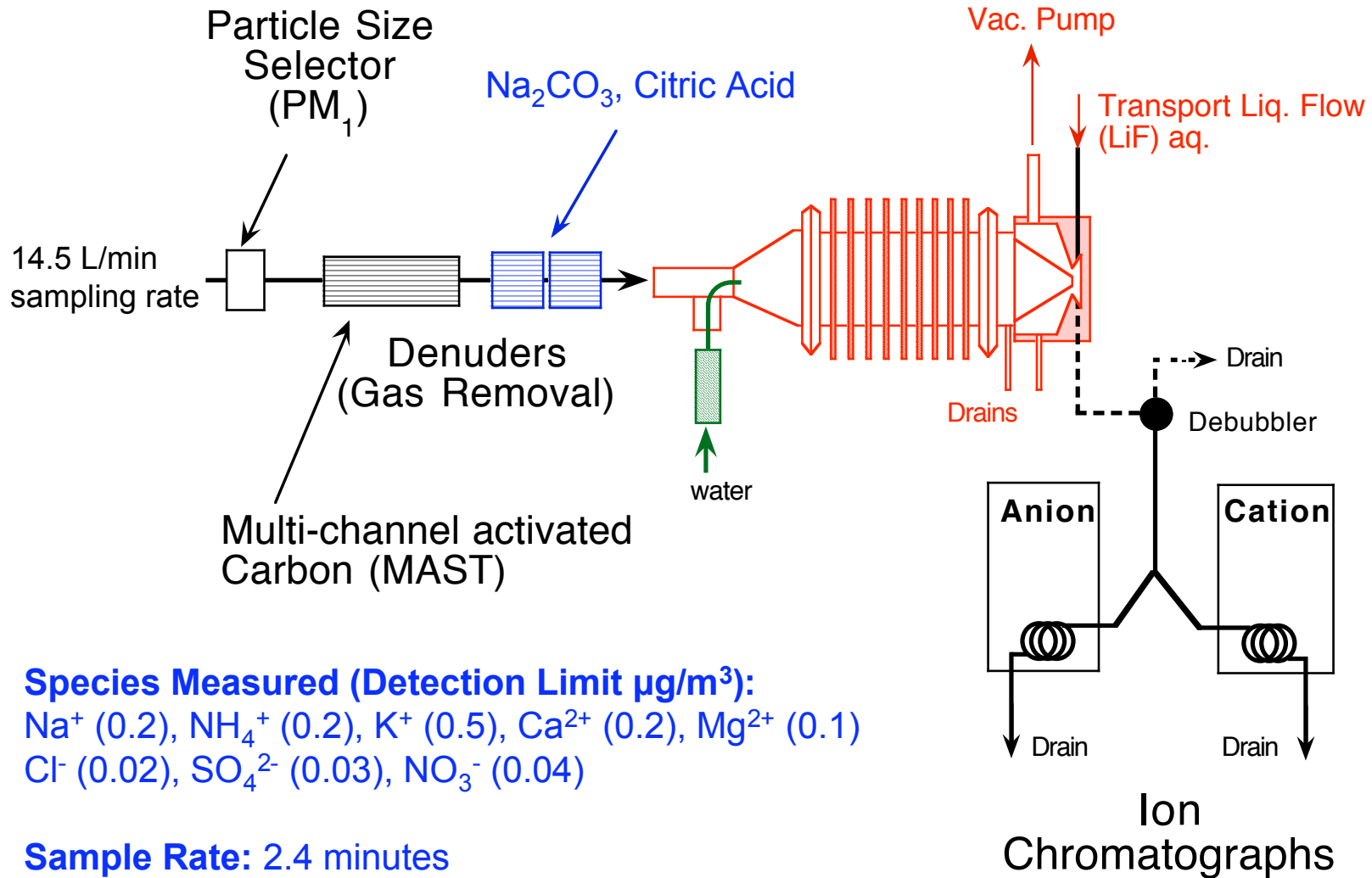


Measurements of Fine Aerosol Inorganic Composition

Chris Hennigan, Scott Sandholm, Rodney Weber
March 2005



Method: PILS-IC



Species Measured (Detection Limit $\mu\text{g}/\text{m}^3$):
 Na^+ (0.2), NH_4^+ (0.2), K^+ (0.5), Ca^{2+} (0.2), Mg^{2+} (0.1)
 Cl^- (0.02), SO_4^{2-} (0.03), NO_3^- (0.04)

Sample Rate: 2.4 minutes

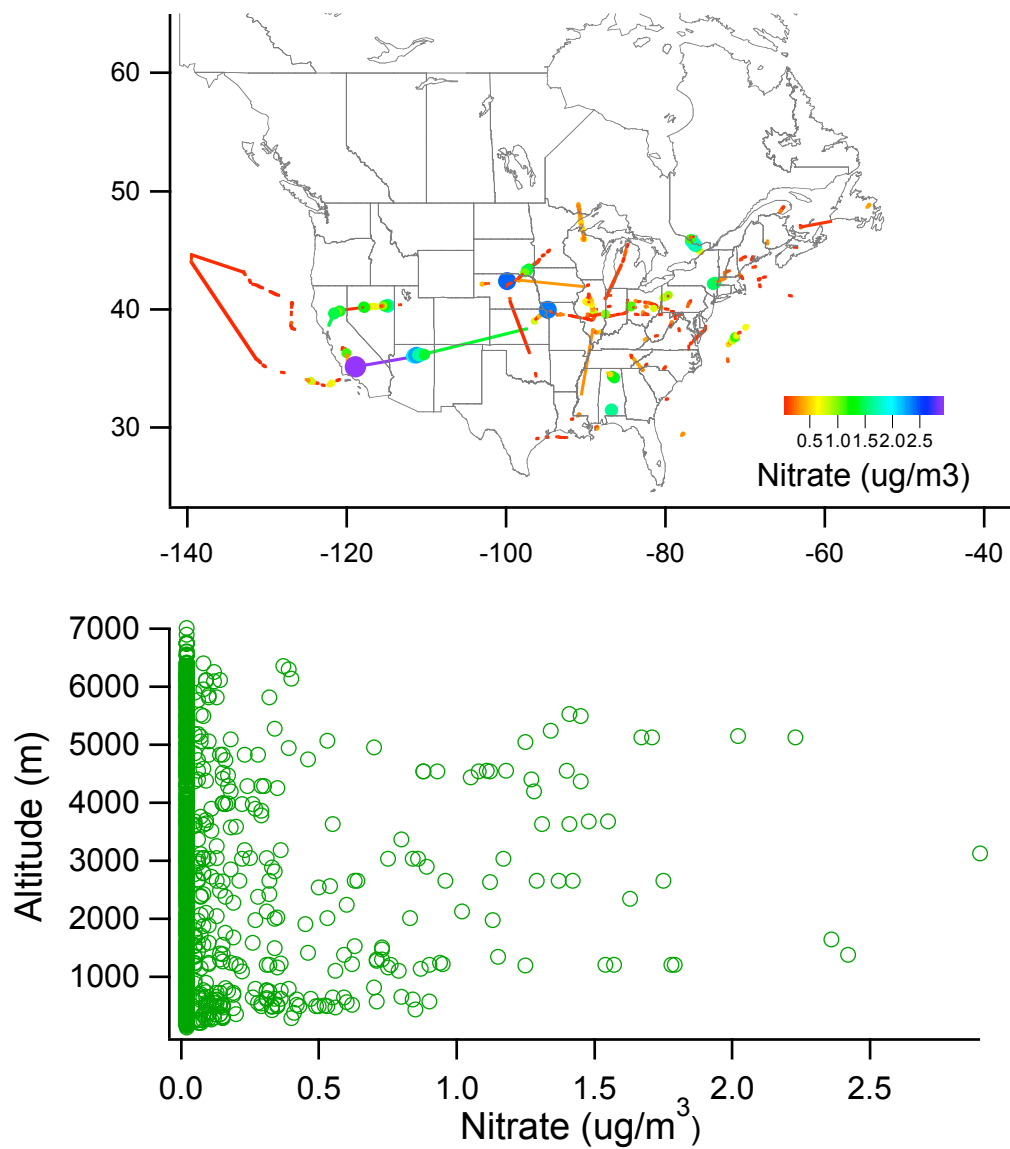
Fine Particle (PM1.0) INTEX-NA Concentrations

All Data: $\mu\text{g}/\text{m}^3$ at 20°C 1 atm

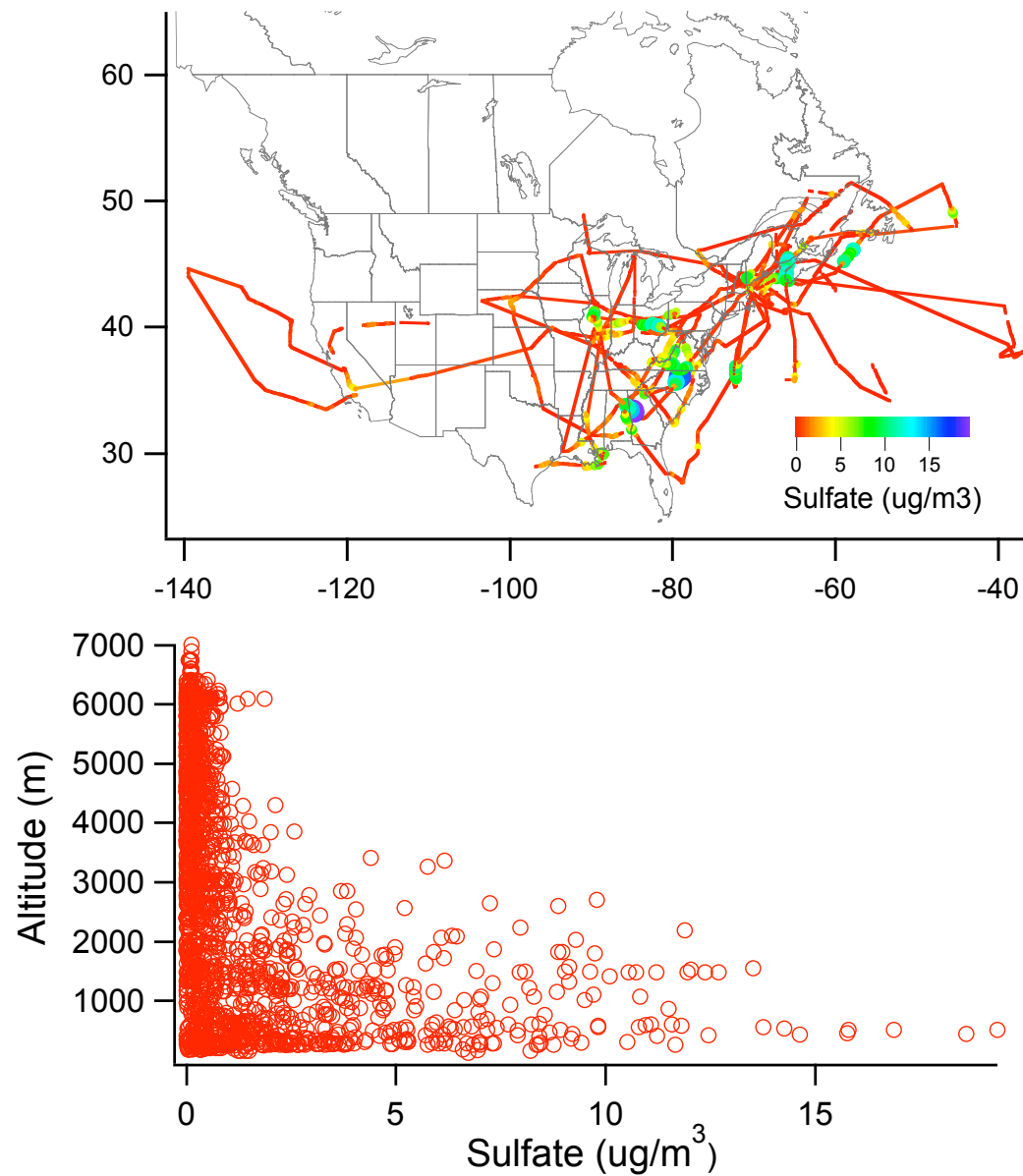
	Mean	Standard Dev.	Min (LOD/2)	Max
Na ⁺	0.11	0.15	0.10	4.35
NH ₄ ⁺	0.92	1.33	0.10	8.28
Ca ²⁺	0.11	0.14	0.10	4.15
K ⁺	0.25	0.18	0.25	7.66
Mg ²⁺	0.05	0.05	0.05	1.90
Cl ⁻	0.02	0.11	0.01	4.34
NO ₃ ⁻	0.09	0.26	0.02	2.90
SO ₄ ²⁻	1.38	2.39	0.02	19.35

- Na⁺, Ca²⁺, K⁺, Mg²⁺, Cl⁻ all near/below LOD throughout mission
- **SO₄²⁻ dominate ionic component**

NO₃ Spatial Distribution (DC-8)

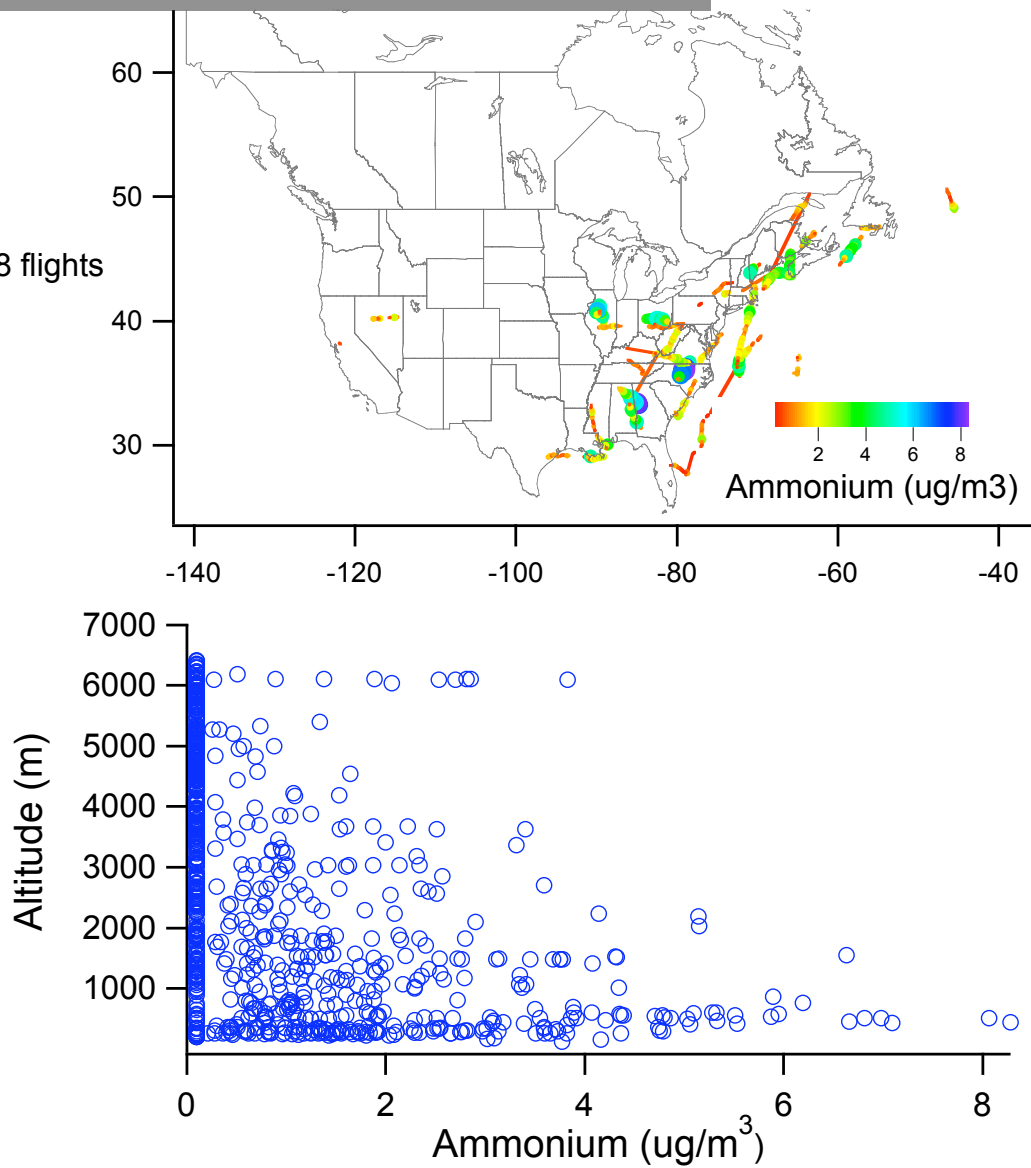


SO₄⁼ Spatial Distribution (DC-8)

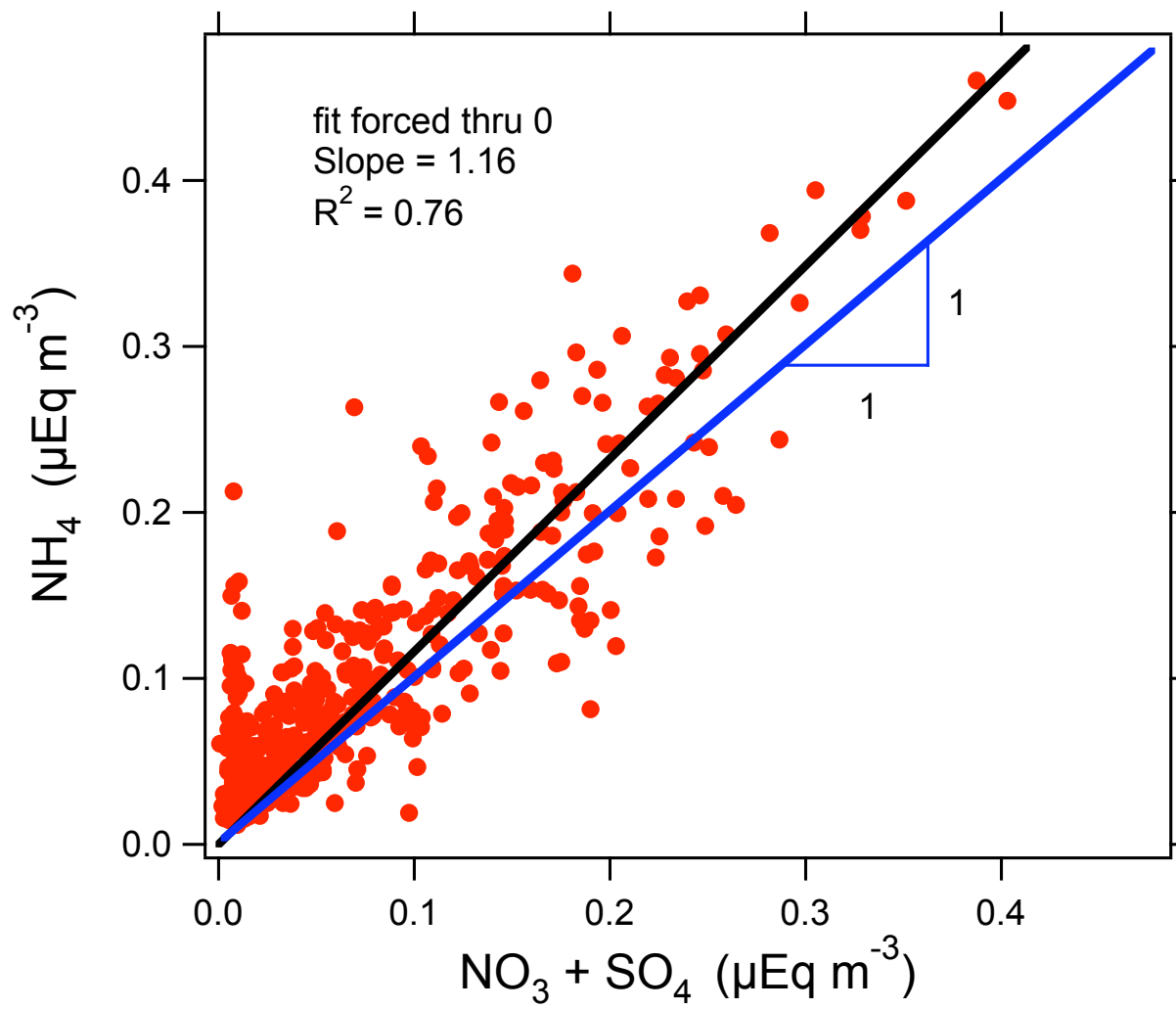


NH₄ Spatial Distribution (DC-8)

Ammonium data for 9 of 18 flights

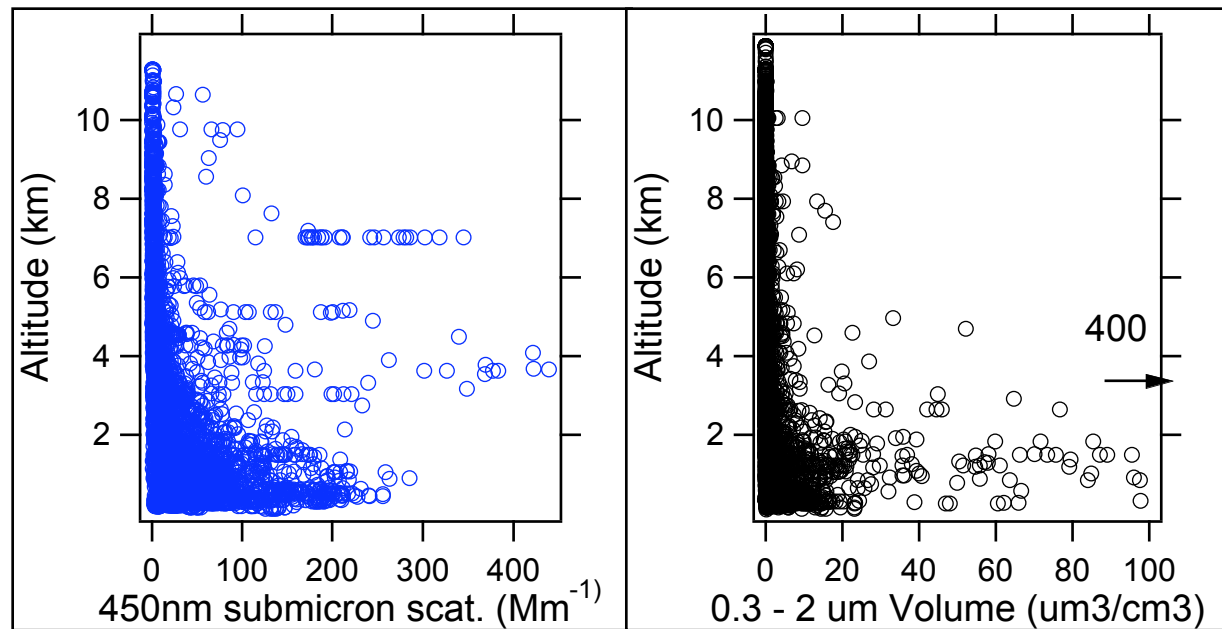
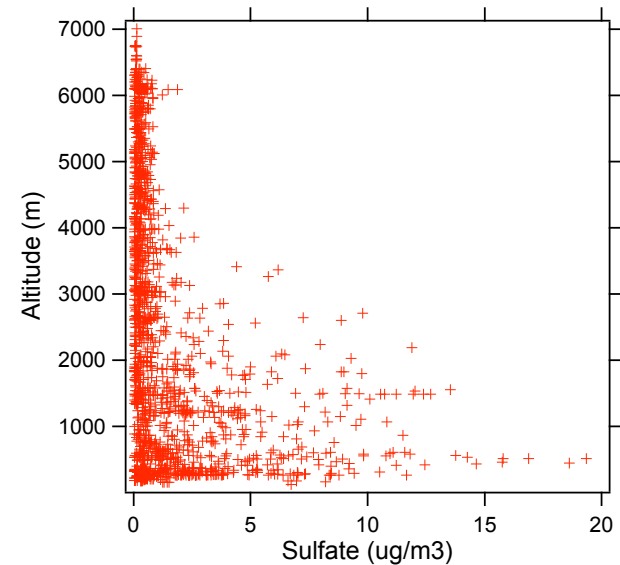


Aerosol apparent acidity: $(\text{NH}_4)_2\text{SO}_4$



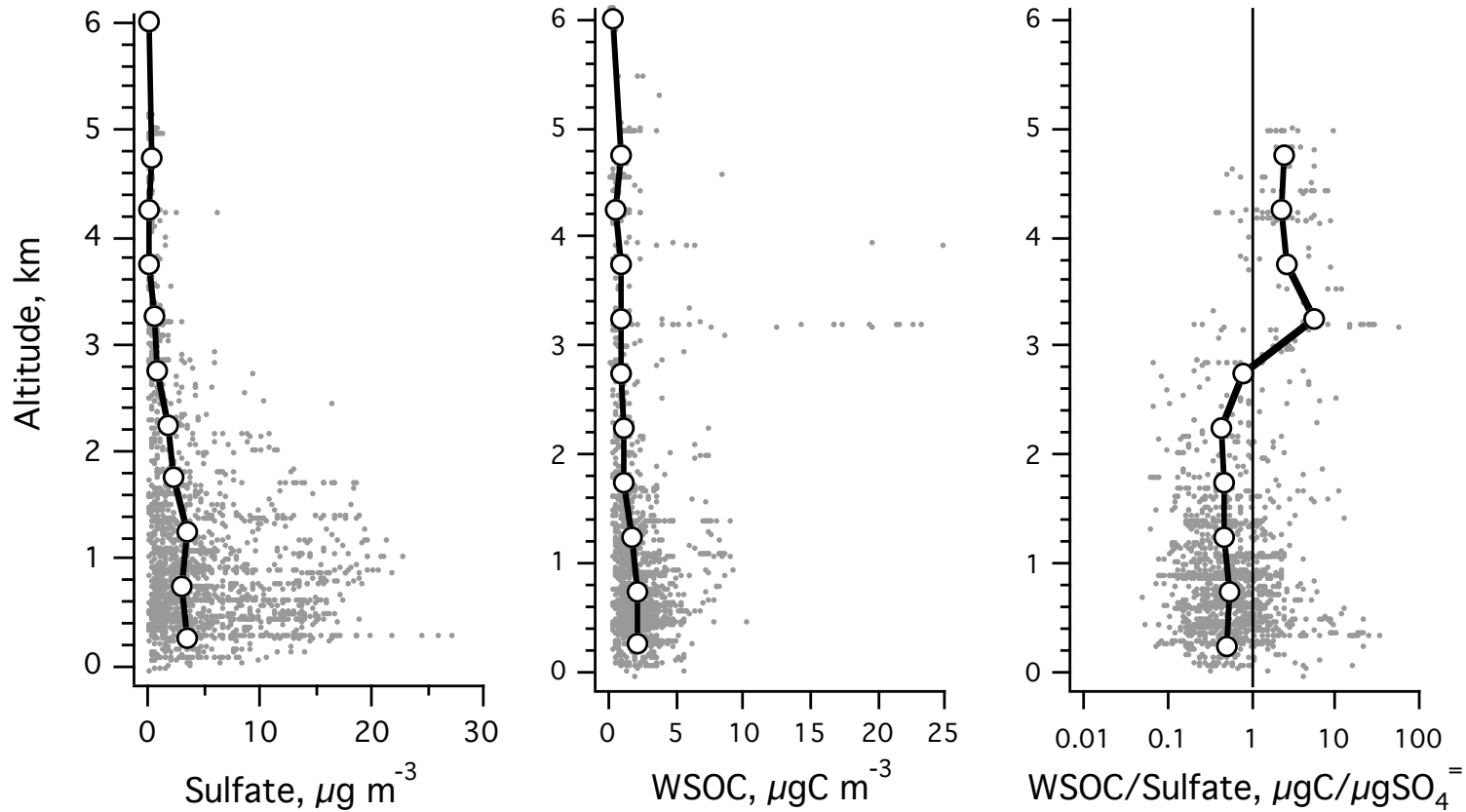
SO₄:

- dominant ionic species
- highest in 0-2 km alt.
- High scattering, vol.



NOAA P3 Results: Similar but Different

- SO_4^- dominates inorganic
- Highest at low altitudes

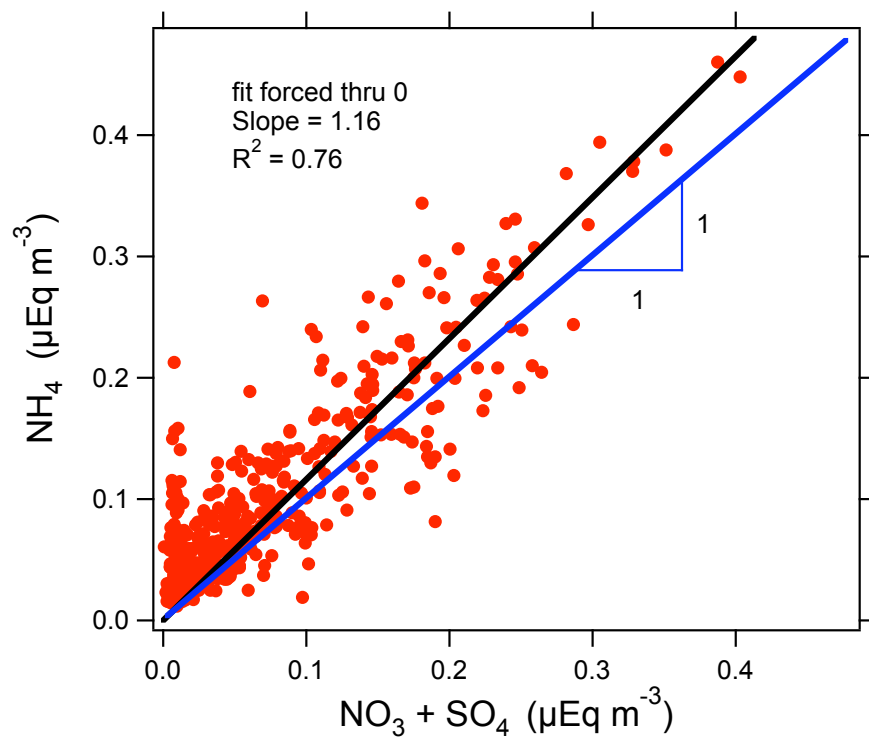


NOAA P3: ITCT 2K4

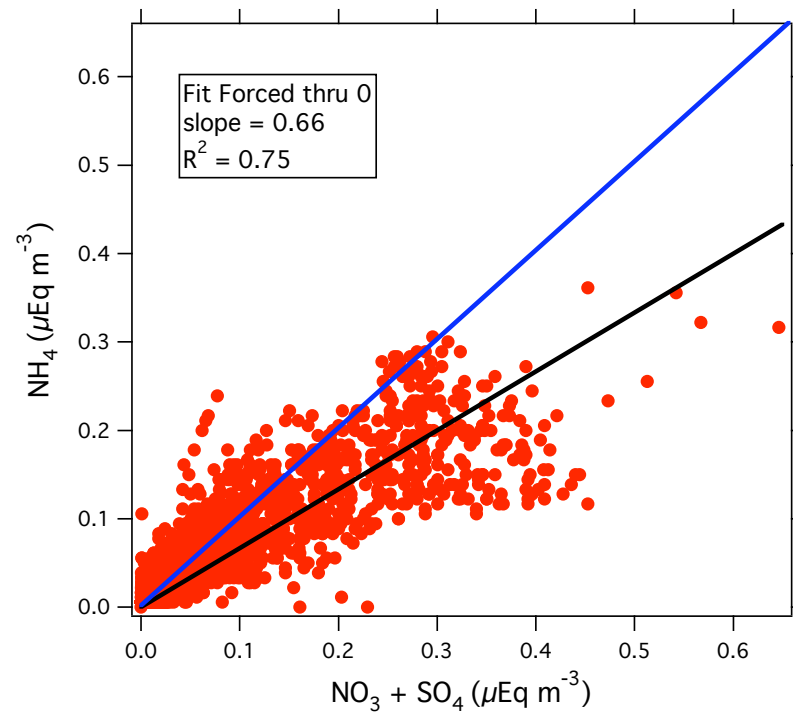
NOAA P3 Results: Similar but Different

- Not as neutralized

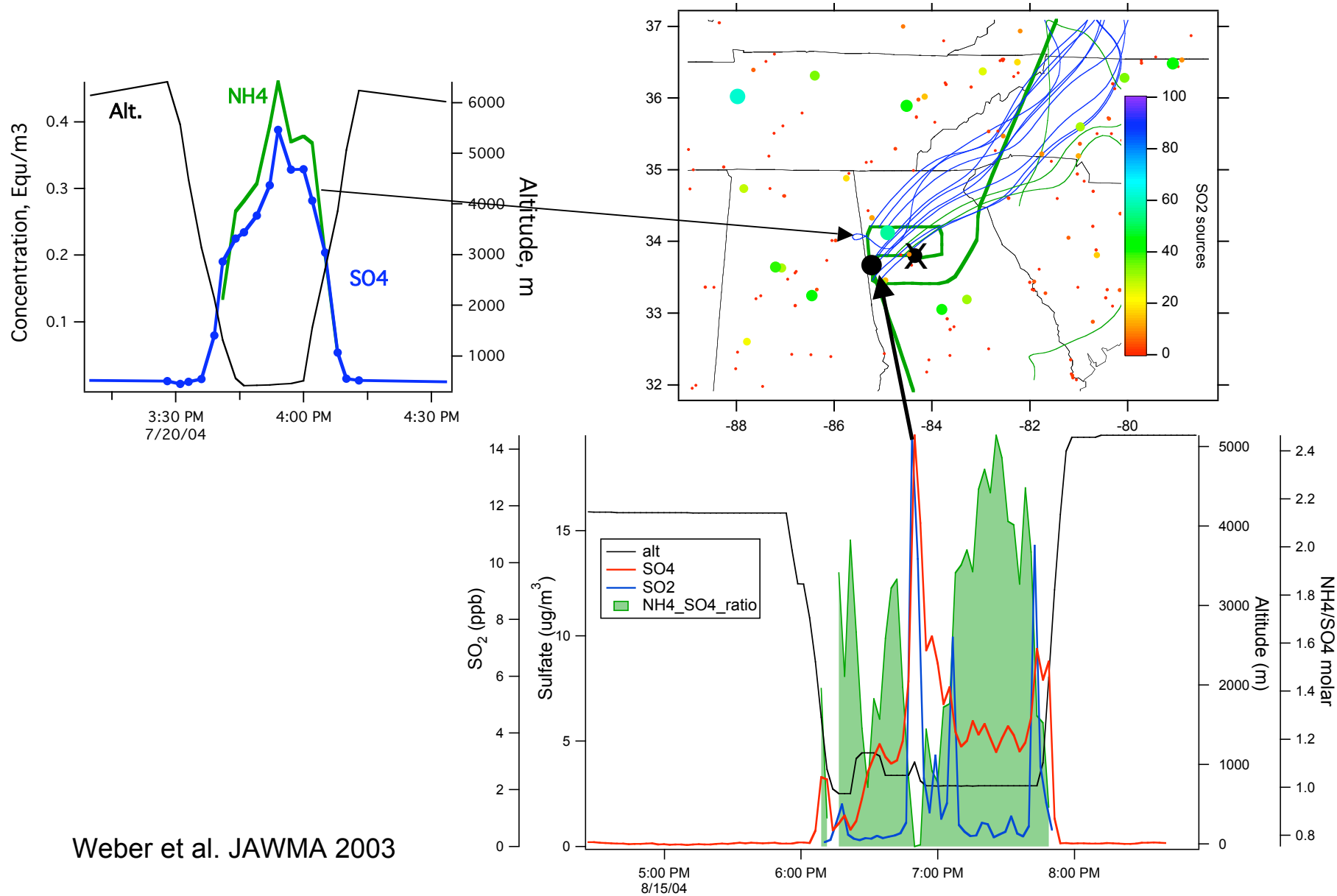
NASA DC-8



NOAA P3



NOAA P3: More Detailed Studies of Specific Plumes

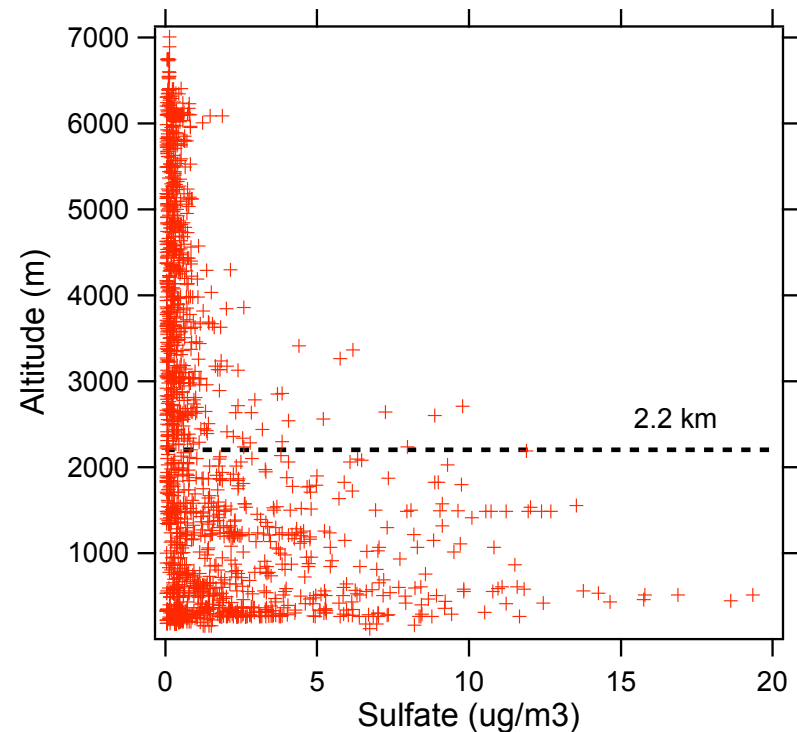


Weber et al. JAWMA 2003

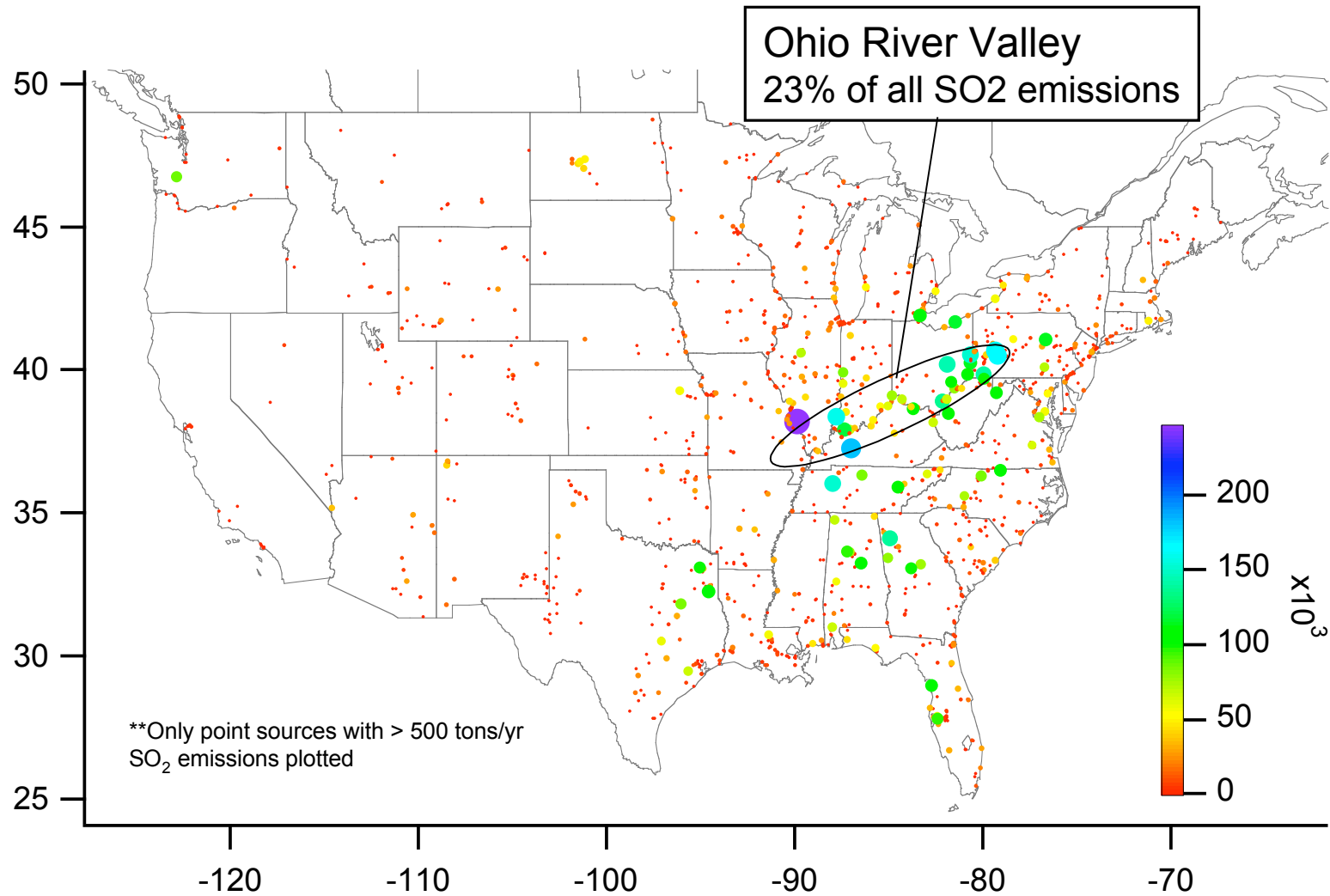
Fine Particle SO_4^- Source ?

A Near-BL Analysis ($z < 2.2 \text{ km}$)

- Analyze legs below 2.2 km alt.
- Each BL pass = 1 data point
- Minimum 3 SO_4^- measurements per pass, ~ constant altitude
- **Total of 79 BL passes analyzed (5 excluded)**



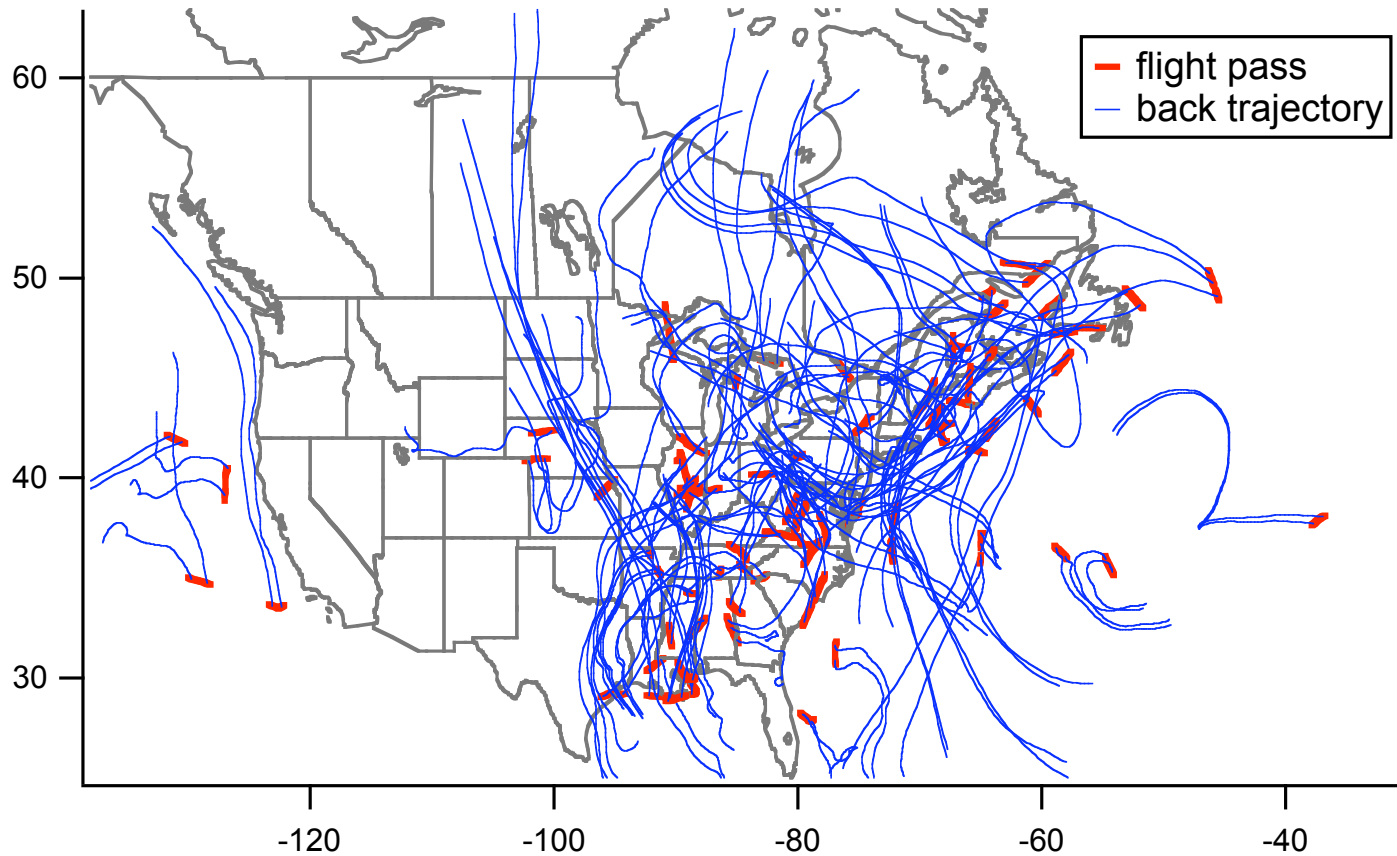
1999 SO₂ Emissions (tons/yr)



Source: EPA National Emissions Inventory 1999, courtesy of NOAA

NOAA HYSPLIT

3-5 day back trajectory for each DC-8 BL pass

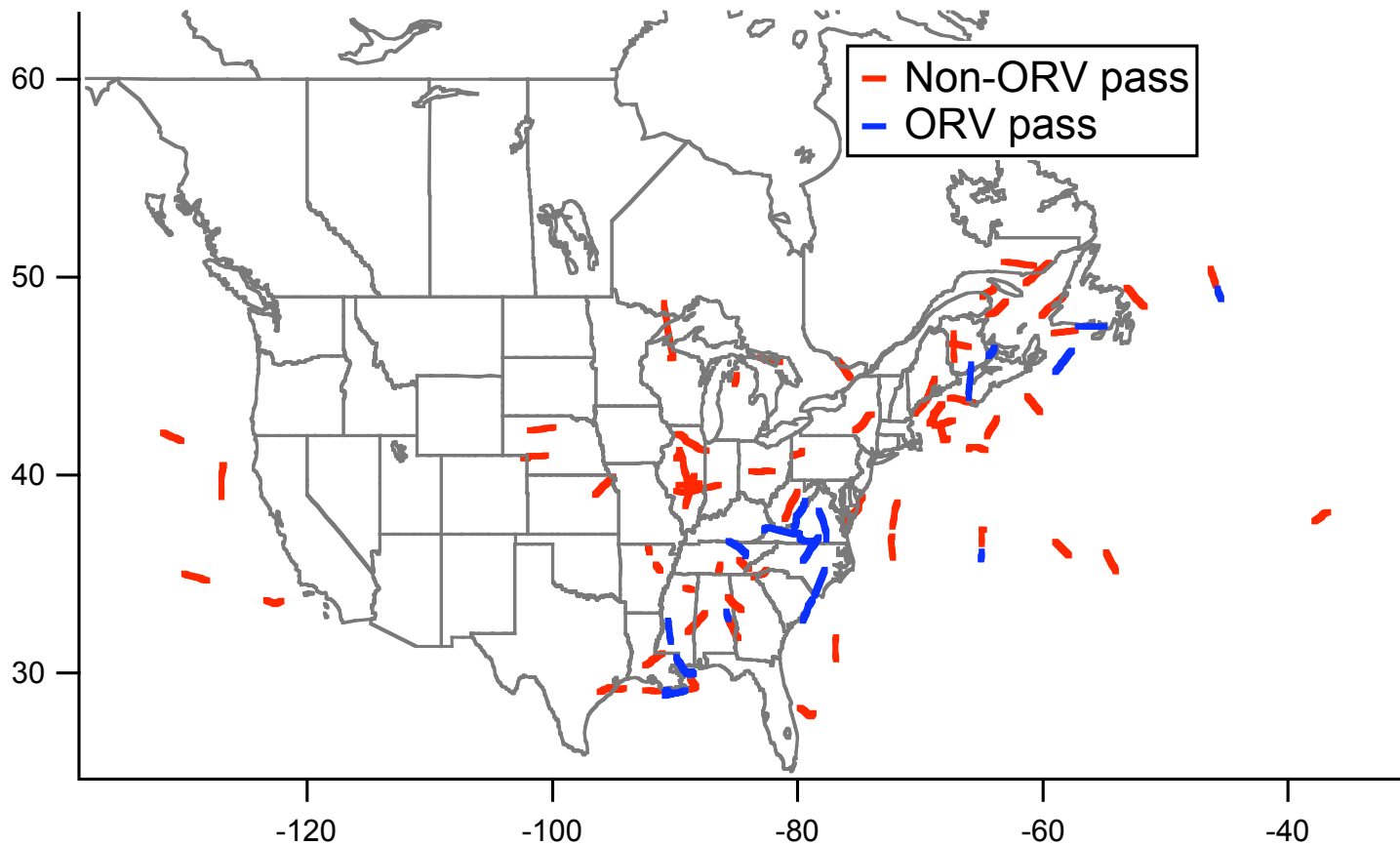


Back Trajectories Analysis for DC-8 Legs, Alt. < 2.3 km

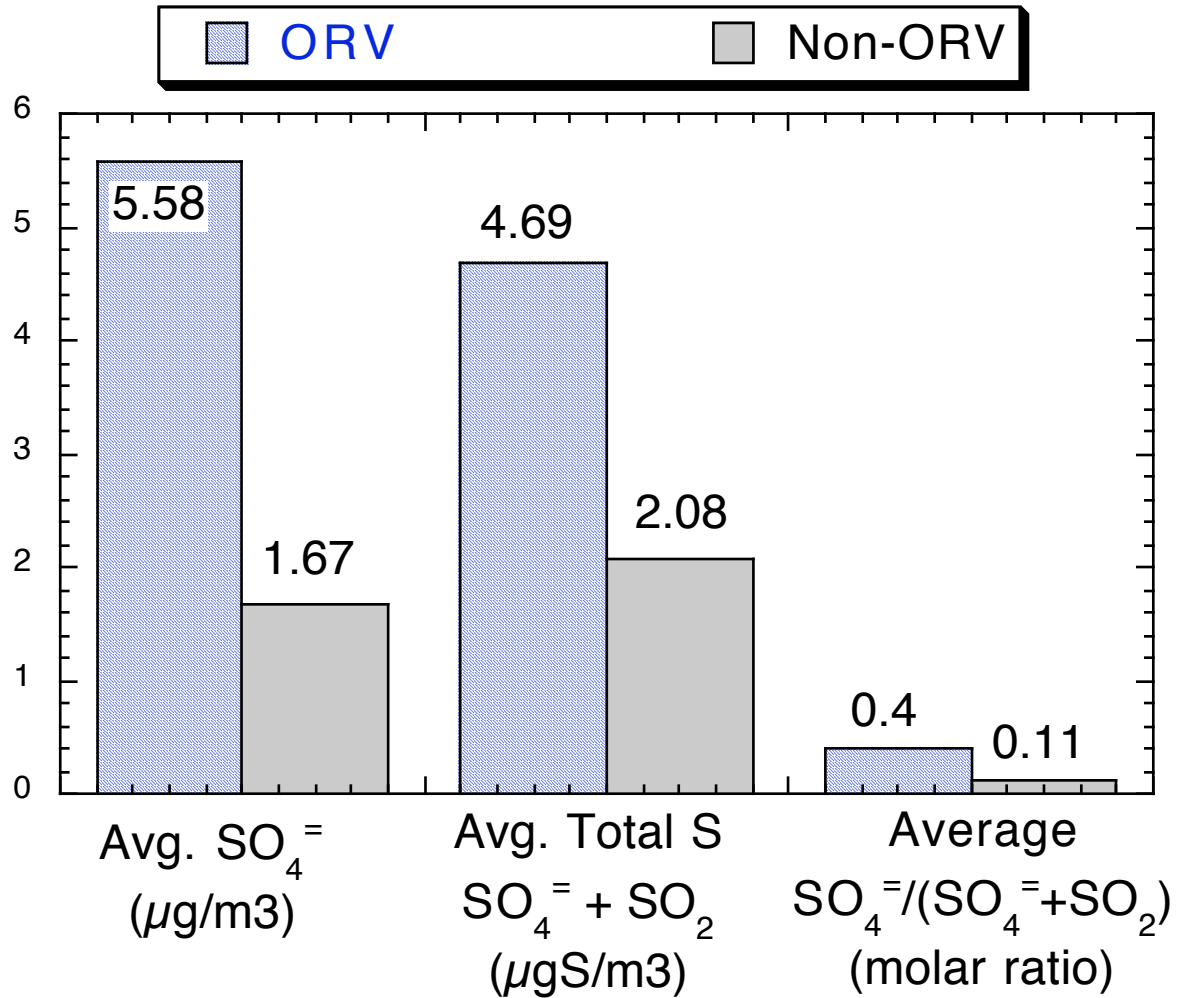
79 BL passes analyzed
(67 are East of Miss. R.)

60 Non-ORV

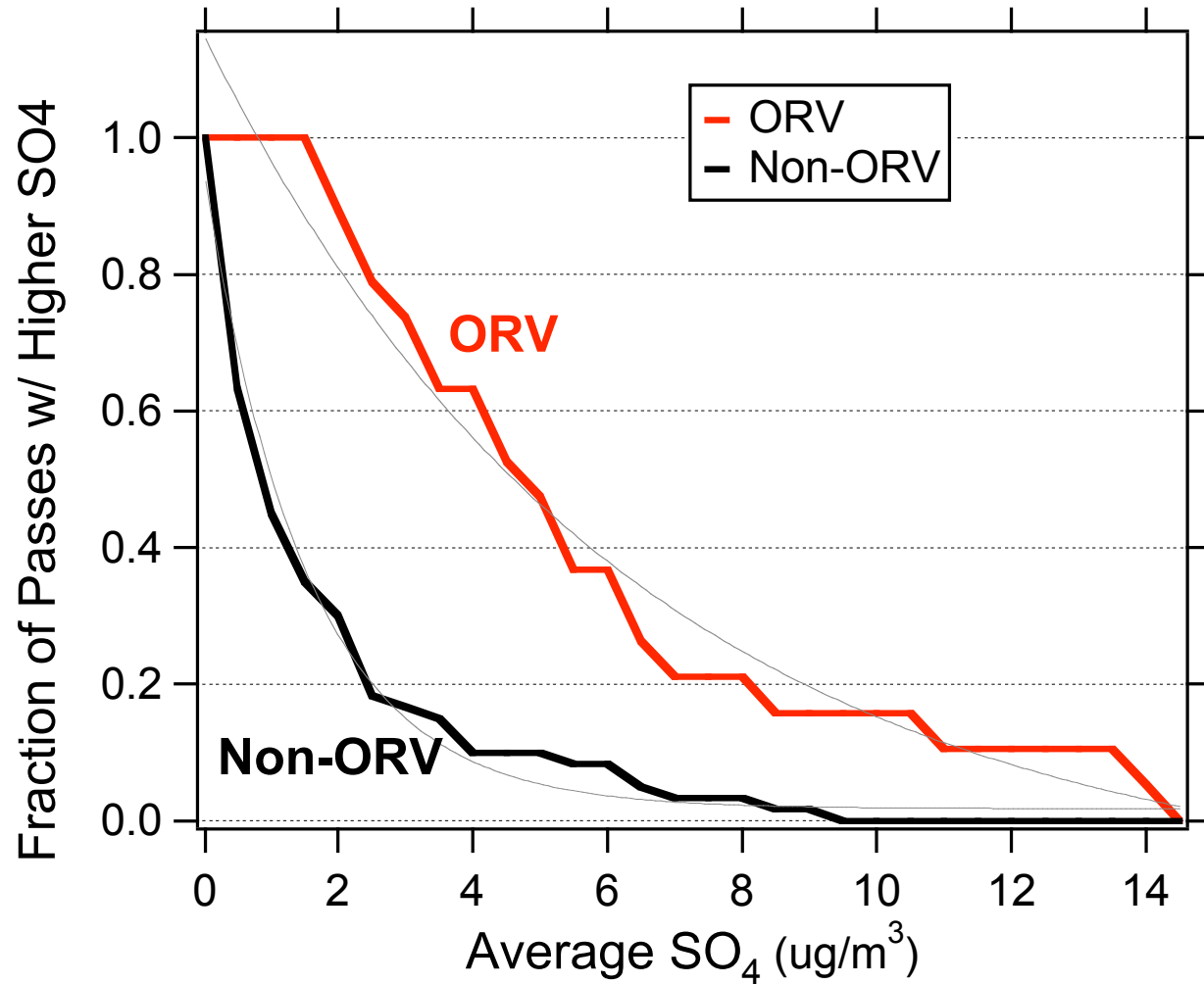
19 ORV, 25%



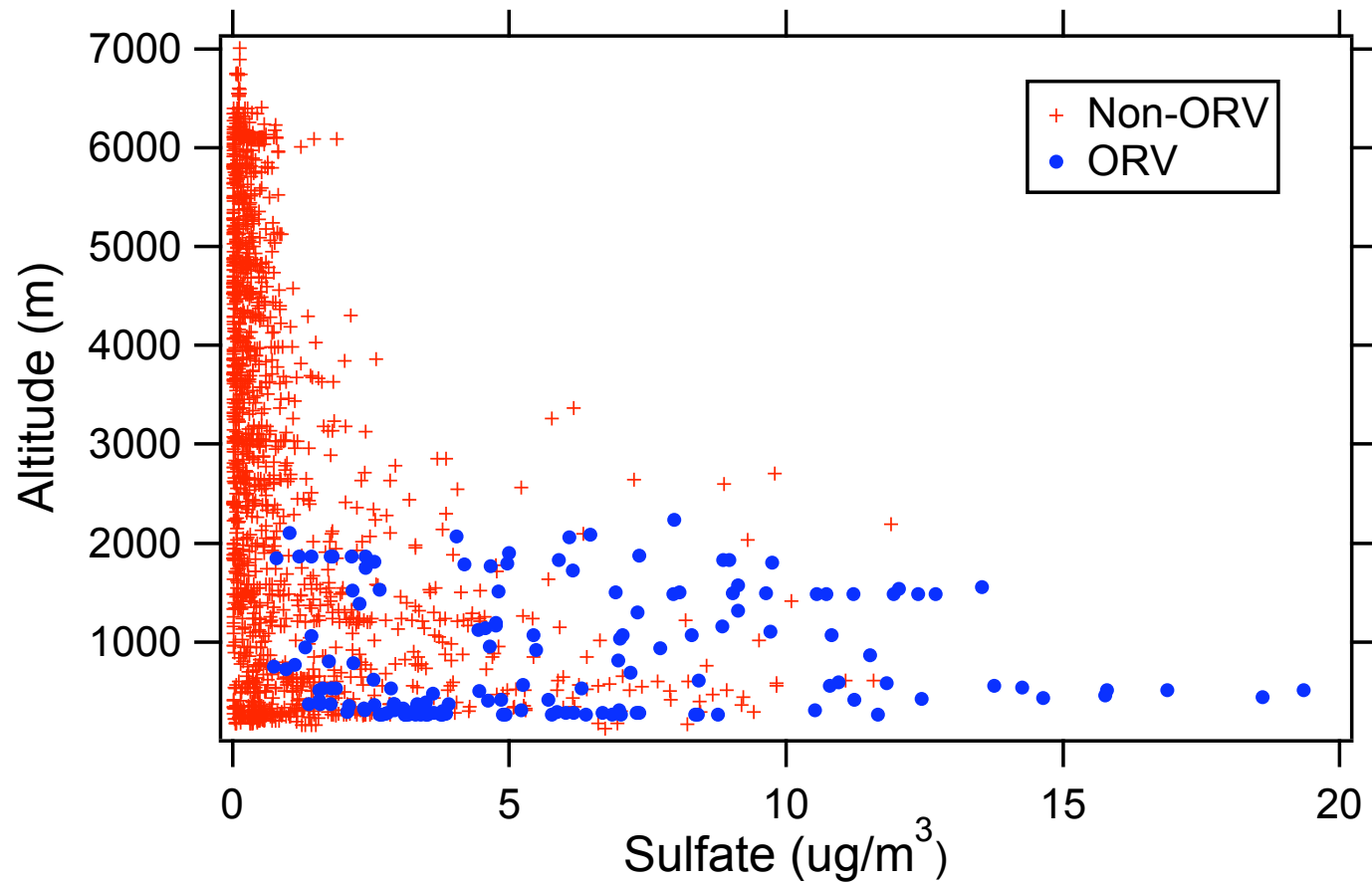
ORV vs. Non-ORV results



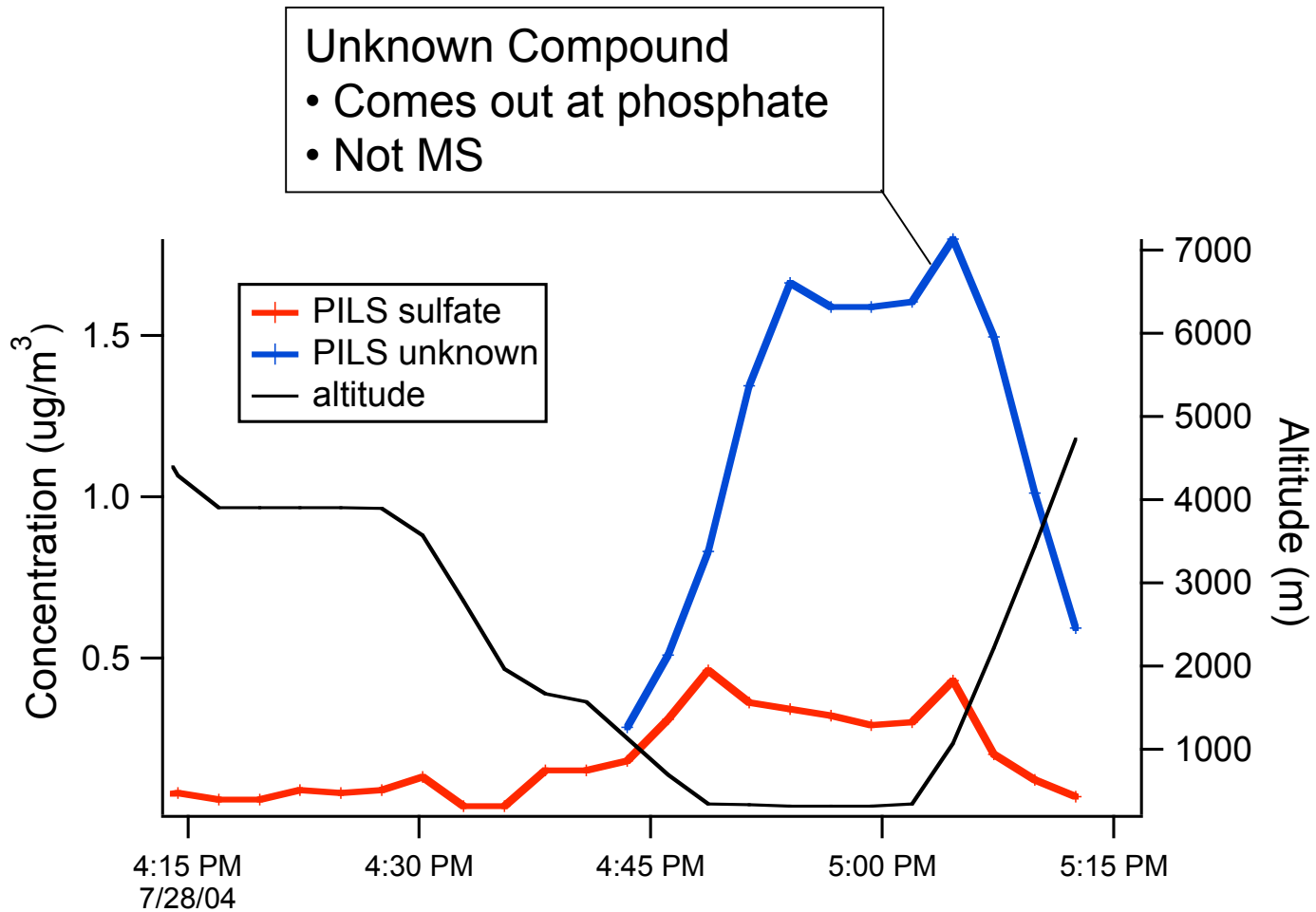
Distribution of sulfate concentration below 2.2 km



Altitude vs. SO_4 : Ohio RV vs. Non-Ohio RV

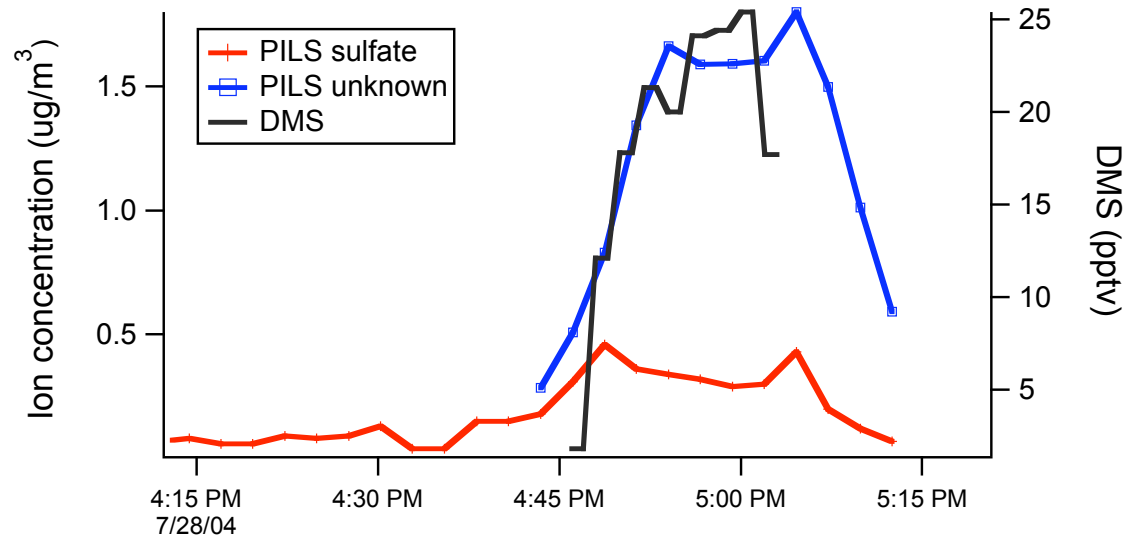
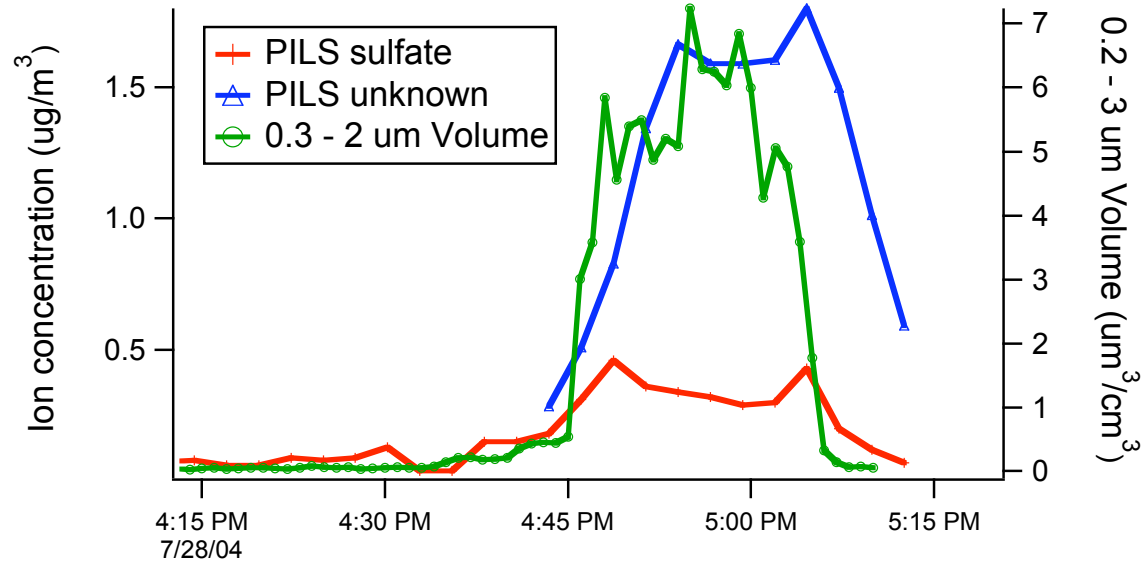


A Unique Compound Observed During Azores Intercomparison Flight 7/28/04



SO_4^- : AMS significantly higher than PILS; generally not observed

Unknown Compound Correlates with "Fine"-Particle Volume and DMS



Summary

- Sulfate: dominant fine inorganic aerosol species measured in summer 2004 INTEX-NA (and NEAQS-ITCT 2004) study
 - Highest at low altitudes
 - DC-8 most often $(\text{NH}_4)_2\text{SO}_4$ (neutralized), not observed on NOAA P3
- Air masses that passed through the Ohio River region contained, on average, 3 times as much SO_4^- (twice as much total S) as those that did not, (observed widely east of Miss. R.).
- Unidentified "fine particle" constituent observed in marine BL
 - Concentrations could be higher than SO_4^{2-} .
 - May be some marine sulfur compound.